24. The system for edge enhancement according to claim 22 wherein the data representative of the relative light intensity of the reference pixel is obtained from an input signal representative of color green (G) in RGB input signals.

Remarks

In view of the above amendments to the specification and the claims, the Applicant respectfully request the Examiner to reconsider the currently pending rejections under 35 U.S.C. §102(b) as well as 35 U.S.C. §103. After entry of this amendment, claims 1 through 24 will remain pending.

The Section 102(b) Rejections

The Examiner has rejected claims 1 through 4 and 6 through 9 under 35 U.S.C. §102(b) as allegedly anticipated by U.S. Pat No 5,886,797 (the Shimura reference). The Examiner has pointed out that every element of the above claims has been anticipated by the disclosures of the Shimura reference. In response to the above rejection basis, the Applicant has amended the independent claims in the following manner.

Newly amended independent claims 1 and 6 now explicitly each recite "extracting a first high frequency portion in a first direction" as well as "a second high frequency portion in a second direction. . . ." Newly amended independent claims 1 and 6 further explicitly each recite "generating selected data from the first frequency portion and the second frequency portion . . . the first direction being perpendicular to the second direction." Lastly, "correction coefficient" is determined "based upon a sign and a value of the reference pixel in the data . . . ." The above explicit recitations of new patentable features include the extraction of the perpendicular first and second high frequency portions from which the selected data is outputted. The selected data is then corrected based upon "the correction coefficient."

In contrast to the above explicit recitations of the patentable features in the newly amended independent claims, the Shimura reference fails to provide the relevant disclosures. The Shimura reference teaches the following relevant disclosures. The edge amount extract unit 2, which acts as a high-pass filter to output the edge amount. Using the edge conversion table 3, a right-shift amount or correction amount is determined based upon the edge amount. Also, using the pixel density conversion table 4, the right-shift amount or correction amount is determined based upon the pixel density. The shift amount selector 5 selects a smaller of the outputs from the edge conversion table 3 and the pixel density conversion table 4. The edge enhancement unit 6 shits the output from the edge amount extract unit 2 by the selected shift amount from the shift amount selector 5. Finally, the adder 7 adds the reference pixel value and the shifted output value from the edge enhancement unit 6. As described above, the Shimura reference discloses the general concept of adjusted correction based upon a selected correction coefficient. However, no disclosure of the Shimura reference fails to teach the explicitly recited new patentable features of the amended independent claims.

Based upon the above reasons, the Applicant respectfully submits to the Examiner that the rejections of newly amended independent claims 1 and 6 are no longer appropriate. Similarly, dependent claims 2 through 4 and 7 through 9 ultimately depend from either of the newly amended independent claims and incorporate the patentable features of newly amended independent claim 1 or 6. Thus, the Applicant respectfully submits to the Examiner that the rejections of claims 1 through 4 and 6 through 9 under 35 U.S.C. §102(b) should be withdrawn.

The Section 103 Rejections

The Examiner has rejected claims 5 and 10 under 35 U.S.C. §103 as allegedly being obvious over the Shimura reference in view of U.S. Pat. No. 6,415,053 (the Norimatsu reference). The Examiner has conceded t with respect to claims 5 and 10 that the Shimura reference fails to disclose a look up table for storing values of the data representative. However, the Examiner has allegedly pointed out that the Norimatsu reference discloses the above look up table. Thus, the Examiner has concluded that it would have been obvious to one of ordinary skill

in the art to combine the disclosures of the two cited references to provide the subject matter limitations of claims 5 and 10.

As discussed above with respect to the section 102(b) rejections, newly amended independent claims 1 and 6 now explicitly each recite extracting a first high frequency portion in a first direction" as well as "a second high frequency portion in a second direction. . . ." Newly amended independent claims 1 and 6 further explicitly each recite "generating selected data from the first frequency portion and the second frequency portion . . . the first direction being perpendicular to the second direction." Lastly, "correction coefficient" is determined "based upon a sign and a value of the reference pixel in the data . . . ."

In relevant portions of the Norimatsu reference, the following disclosures have been considered. The gradient is defined as a differential "representing each of directions and intensities of the pixel of interest and its surrounding pixels." (lines 35 through 38 in column 17). The gradient calculation device 80 determines the gradients of the pixel of interest or the reference pixel and the surrounding pixels. Based upon the above determined gradients, the connectivity calculating device 82 determines the connectivity of the reference pixel. The directivity calculating device 84 determines the gradients for each of R, G and B of the reference pixel and then the directivities based upon the gradients. Based upon the connectivity and the gradients, the edge portion deciding and extracting device 86 determines whether or not the reference pixel is an edge-portion and then extracts the edge portion. With respect to the description of Figure 8, four steps are disclosed as follows to determine the edge portion:

> [A]t step 1 the direction and intensity of the gradient of the pixel of interest are calculated. At step 2, gradients of two adjacent pixels in the direction of 90 degrees from the direction of the gradient of the pixel of interest are calculated whereby their directivities are checked. At step 3, directions of two adjacent pixels and the pixel of interest are compared. If each of the former ones has the directivities within 45 degrees from the direction of the pixel of interest, it is treated that each of them has connectivity. At step 4, gradients of the pixel of interest corresponding to respective R, G and B channels are calculated whereby their directivities are checked. At the last step, that is, step 5, based on the obtained connectivity and the directivities of respective R, G and B, the

pixel of interest is decided whether it is the edge portion or not. (lines 32 through 46 in column 22).

The distinction is patentably clear between the above disclosures and the current invention. The Norimatsu reference discloses that the edge portion is determined ultimately based upon the gradient that is a differential "representing each of directions and intensities of the pixel of interest and its surrounding pixels." In sharp contrast, the current invention as explicitly recited in newly amended independent claims 1 and 6 does not require the use of the gradients. Furthermore, newly amended independent claims 1 and 6 each require that the directions of "the first high frequency potion" and "the second high frequency portion" are "perpendicular" with each other. Finally, as also explicitly recited in newly amended independent claims 1 and 6, "the selected data" is outputted from the first high frequency portion and the second high frequency portion."

In other words, the data to be corrected by the selected correction coefficient is clearly selected in a patentably distinct manner in the current invention as explicitly recited in newly amended independent claims 1 and 6. Based upon the above reasons, the Applicant respectfully submits to the Examiner that it would not have been obvious to one of ordinary skill in the art to provide the above two patentable features based upon the disclosures of the Shimura reference and the Norimatsu reference alone or in combination. Therefore, the Applicant respectfully submits to the Examiner that the rejections of claims 5 and 10 under 35 U.S.C. §103 should be withdrawn.

Newly Added Claims

Dependent claims 11 through 24 have been added in the current amendment. Since the patentable features of the newly added dependent claims have been supported by the original disclosures of the current application, no new matter has been added in the current application. Thus, the Applicant respectfully requests the Examiner to enter the newly added dependent claims.

The Specification Amendment

The amendment to the specification has been made to clarify the subject matter limitation of the original disclosures in the current application. The word, "reference" has been added in front of the pixel in order to clarify that the pixel is the one currently under consideration. The addition of the clarification does not introduce new matter and should not change the scope of the prior art search. Thus, the Applicant respectfully requests the Examiner to enter the amendments to the specification.

Conclusion

In view of the above amendments and the foregoing remarks, Applicants respectfully submit that all of the pending claims are in condition for allowance and respectfully request a favorable Office Action so indicating.

Respectfully submitted,

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signals are outputted to output devices such as a display device. On the other hand, the light intensity signal Y is processed by an aperture correction device 106.

Still referring to FIGURE 4, the aperture correction device106 corrects degraded data which includes a high frequency portion representing patterns such as a continuously repeated pattern and an abrupt intensity change pattern. The image data is generally more adversely affected as an aperture size increases. The aperture correction is generally more effective at a low-resolution level such as 100 dpi or 100, 000 charged-couple device (CCD) elements. The aperture correction device 106 includes a pair of high-pass filtering units 110 and 111 for extracting a high frequency portion of the intensity light signal Y. The vertical high-pass filtering unit 110 extracts a high frequency portion of the relative light intensity signal in a substantially vertical direction while the horizontal high-pass filtering unit 111 extracts a high frequency portion of the relative light intensity signal in a substantially horizontal direction. A mixing unit 112 compares the absolute values of the vertical and horizontal high frequency portions of the relative light intensity signal. If the absolute values are substantially the same, the average of the two is outputted for further processing by a coring unit 113. On the other hand, if the two values are different, the larger of the two is outputted for further processing by the coring unit 113. The coring unit 113 reduces noise of the extracted high frequency portions of the light intensity signal within a predetermined core range. In other words, between the two threshold values, the noise is reduced to zero. A gain adjust unit 114 amplifies the noise reduced signal according to a predetermined gain value. The gain adjust unit 114 outputs an amplified signal as well as an associated sign signal.

The first preferred embodiment of the aperture correction system according to the current invention includes a look-up table unit 115 which outputs an appropriate correction coefficient. The look-up table unit 115 stores a predetermined set of correction coefficients and selects a multiplication coefficient for a multiplication unit 116 based upon the sign signal and an original relative light intensity signal Y of a reference pixel. The sign is determined by a relation between the relative light intensity of the pixel and that of pixels surrounding the pixel. For example, one implementation is that the sign is positive when a value of the data representative of the relative intensity of a reference pixel is larger than that of surrounding pixels. For the same example, the sign is negative when a value of the data representative of the relative intensity of the reference pixel is smaller than that of

WHAT IS CLAIMED IS:

1. A method of edge enhancement, comprising the acts of:

extracting a first high frequency portion in a first direction of data representative of relative light intensity of a reference pixel;

extracting a second high frequency portion in a second direction of data representative of relative light intensity of the reference pixel, the first direction being perpendicular to the second direction;

outputting selected data from the first high frequency portion and the second high frequency portion;

determining a correction coefficient based upon a sign and a value of the ~~extracted high frequency portion of~~ reference pixel in the data, the sign being indicative of a relation between the relative light intensity of the reference pixel and that of pixels surrounding the reference pixel; and

correcting the selected data based upon the correction coefficient.

2. The method of edge enhancement according to claim 1 wherein said sign is positive when a value of the data representative of the relative intensity of the reference pixel is larger than that of surrounding pixels.

3. The method of edge enhancement according to claim 1 wherein said sign is negative when a value of the data representative of the relative intensity of the reference pixel is smaller than that of surrounding pixels.

4. The method of edge enhancement according to claim 1 wherein the data representative of the relative light intensity of the reference pixel is obtained from an input signal representative of color green (G) in RGB input signals.

5. The method of edge enhancement according to claim 1 wherein a predetermined set of values is stored in a lookup table for selecting the correction coefficient value.

WHAT IS CLAIMED IS:

1. A method of edge enhancement, comprising the acts of:

extracting a first high frequency portion in a first direction of data representative of relative light intensity of a reference pixel;

extracting a second high frequency portion in a second direction of data representative of relative light intensity of the reference pixel, the first direction being perpendicular to the second direction;

outputting selected data from the first high frequency portion and the second high frequency portion;

determining a correction coefficient based upon a sign and a value of the ~~extracted high frequency portion of~~ reference pixel in the data, the sign being indicative of a relation between the relative light intensity of the reference pixel and that of pixels surrounding the reference pixel; and

correcting the selected data based upon the correction coefficient.

2. The method of edge enhancement according to claim 1 wherein said sign is positive when a value of the data representative of the relative intensity of the reference pixel is larger than that of surrounding pixels.

3. The method of edge enhancement according to claim 1 wherein said sign is negative when a value of the data representative of the relative intensity of the reference pixel is smaller than that of surrounding pixels.

4. The method of edge enhancement according to claim 1 wherein the data representative of the relative light intensity of the reference pixel is obtained from an input signal representative of color green (G) in RGB input signals.

5. The method of edge enhancement according to claim 1 wherein a predetermined set of values is stored in a lookup table for selecting the correction coefficient value.

6. A system for edge enhancement, comprising:

an extraction unit for extracting a first high frequency portion in a first direction and a second high frequency portion in a second direction of data representative of relative light intensity of a reference pixel, the first direction being perpendicular to the second direction;

a mixing unit connected to said extraction unit for outputting selected data from the first frequency portion and the second high frequency portion;

a determination unit connected to said ~~extraction~~ mixing unit for determining a correction coefficient based upon a sign and a value of the ~~extracted high frequency portion~~reference pixel in of the data, the sign being indicative of a relation between the relative light intensity of the reference pixel and that of pixels surrounding the reference pixel; and

a correction unit connected to said determination unit and said extraction unit for correcting the selected data based upon the correction coefficient.

7. The system for edge enhancement according to claim 6 wherein said sign is positive when a value of the data representative of the relative intensity of the reference pixel is larger than that of surrounding pixels.

8. The system for edge enhancement according to claim 6 wherein said sign is negative when a value of the data representative of the relative intensity of the reference pixel is smaller than that of surrounding pixels.

9. The system for edge enhancement according to claim 6 wherein the data representative of the relative light intensity of the reference pixel is obtained from an input signal representative of color green (G) in RGB input signals.

10. The system for edge enhancement according to claim 6 wherein said determination unit further comprises a look up table storing a predetermined set of values for selecting the correction coefficient value.

11. The method of edge enhancement according to claim 1 wherein the first direction and the second direction are respectively horizontal and vertical.

12. The method for edge enhancement according to claim 6 where the first direction and the second direction are respectively horizontal and vertical.

13. The method of edge enhancement according to claim 1 wherein the selected data is the larger of the first high frequency portion and the second high frequency portion when the first high frequency portion is substantially different from the second high frequency portion in absolute value.

14. The system for edge enhancement according to claim 6 wherein the selected data is the larger of the first high frequency portion and the second high frequency portion when the first high frequency portion is substantially different from the second high frequency portion in absolute value.

15. The method of edge enhancement according to claim 1 wherein the selected data is an average of the first high frequency portion and the second high frequency portion when the first high frequency portion and the second high frequency portion are substantially similar in absolute value.

16. The system for edge enhancement according to claim 6 wherein the selected data is an average of the first high frequency portion and the second high frequency portion when the first high frequency portion and the second high frequency portion are substantially similar in absolute value.

17. A method of edge enhancement, comprising the acts of:

extracting a high frequency portion of data representative of relative light intensity of a reference pixel;

limiting the data based upon a predetermined range to generate limited data;

determining a correction coefficient based upon a sign and a value of the

reference pixel in the data. the sign being indicative of a relation between the relative light intensity of the reference pixel and that of pixels surrounding the reference pixel; and

correcting the limited data based upon the correction coefficient.

18. The method of edge enhancement according to claim 17 wherein said sign is positive when a value of the data representative of the relative intensity of the reference pixel is larger than that of surrounding pixels.

19. The method of edge enhancement according to claim 17 wherein said sign is negative when a value of the data representative of the relative intensity of the reference pixel is smaller than that of surrounding pixels.

20. The method of edge enhancement according to claim 17 wherein the data representative of the relative light intensity of the reference pixel is obtained from an input signal representative of color green (G) in RGB input signals.

21. A system for edge enhancement, comprising:

an extraction unit for extracting a high frequency portion of data representative of relative light intensity of a reference pixel;

a limiting unit connected to said extraction unit for limiting data based upon a predetermined range and for generating limited data;

a determination unit connected to said limiting unit for determining a correction coefficient based upon a sign and a value of the reference pixel in of the data, the sign being indicative of a relation between the relative light intensity of the reference pixel and that of pixels surrounding the reference pixel; and

a correction unit connected to said determination unit and said limiting unit for correcting the limited data based upon the correction coefficient.

22. The system for edge enhancement according to claim 21 wherein said sign is positive when a value of the data representative of the relative intensity of the reference pixel is larger than that of surrounding pixels.

23. The system for edge enhancement according to claim 22 wherein said sign is negative when a value of the data representative of the relative intensity of the reference pixel is smaller than that of surrounding pixels.

24. The system for edge enhancement according to claim 22 wherein the data representative of the relative light intensity of the reference pixel is obtained from an input signal representative of color green (G) in RGB input signals.